BENEFITS OF THE THERMALLY STIMULATED LUMINESCENCE IN THE STUDY OF RADIATION-INDUCED COLOUR CENTRES IN YTTERBIUM-DOPED SILICA-BASED OPTICAL FIBRES

Franck Mady, Mourad Benabdesselam, Wilfried Blanc, Bernard Dussardier

BENEFITS OF THE THERMALLY STIMULATED LUMINESCENCE IN THE STUDY OF RADIATION-INDUCED COLOUR CENTRES IN YTTERBIUM-DOPED SILICA-BASED OPTICAL FIBRES

F. Mady, M. Benabdesselam, W. Blanc*, B. Dussardier

University of Nice-Sophia Antipolis, LPMC, CNRS UMR 6622 Parc Valrose, 06108 Nice

Ytterbium-doped silica-based optical fibres (YDF) are of interest in a large variety of applications (medicine, space communications...) requiring very high output power laser sources at ~1µm. The amplifying performances of YDF are damaged due to the high inversion rates of Yb^{3+} ions achieved by the pump (photo-darkening [1]), and possibly by radiations of the harsh environment where they are operated, as e.g. in space (radio-darkening [2]). Both darkening effects are indeed responsible for the formation of colour centres which absorption bands spread from UV up to visible with significant tails at the near-IR pump and gain wavelengths. So far, radiation-induced centres in silica optical fibres have been investigated by absorption measurements or photoluminescence-like methods [3]. Our work aims at demonstrating the benefits of the thermally stimulated luminescence (TSL) in elucidating the darkening mechanisms. TSL is a well known technique that has been used for decades in solid-state dosimetry or dating. Its application to the study of radiation damage in silica fibres is nevertheless very original and will be shown to be fruitful.

Due to electronic excitation, irradiation is responsible for changes in the redox state of traps, dopants or pre-existing optically active centres. These changes can contribute to excess optical losses. TSL precisely reveals those centres that have undergone such alterations. It not only detects emitting centres, but also has the crucial advantage of showing non-luminescent defects that can be involved in the radiation-induced absorption.

By considering samples of ytterbium-doped silica glass from fibre preforms, we will show how TSL allows direct comparison between colour centres created by X-ray, UV light (at several wavelengths) and by the visible radiation of an Ar^+ ion laser. This comparison will lead us to propose plausible darkening mechanisms with related models.

[1] J.J. Koponen et al., Appl. Opt. 47 (2008) 1247

[2] B.P. Fox el al., Proceedings of SPIE, 6453 (2007) 645328

[3] B. Tortech et al., J. Non-Crystal. Solids 355 (2009) 1085.

* **E-mail**: wilfried.blanc@unice.fr (presenter)

Keywords: ytterbium-doped silica glass, radiation-induced colour centres, thermally stimulated luminescence.